US007819312B2

(12) **United States Patent**
Gualandri

(10) **Patent No.: US 7,819,312 B2**
(45) **Date of Patent: Oct. 26, 2010**

(54) **METHOD AND SYSTEM FOR OPERATING MACHINES**

(75) Inventor: **J. Joseph Gualandri**, Metamora, IL (US)

(73) Assignee: **Caterpillar Inc**, Peoria, IL (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 1094 days.

(21) Appl. No.: **11/495,545**

(22) Filed: **Jul. 31, 2006**

(65) **Prior Publication Data**

US 2008/0121684 A1 May 29, 2008

Related U.S. Application Data

(63) Continuation-in-part of application No. 11/477,514, filed on Jun. 30, 2006.

(51) **Int. Cl.**
G06K 5/00 (2006.01)

(52) **U.S. Cl.** **235/382**

(58) **Field of Classification Search** 235/382; 701/50

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,177,466	A	12/1979	Reagan
4,818,998	A	4/1989	Apsell et al.
5,055,851	A	10/1991	Sheffer
5,229,648	A	7/1993	Sues et al.
5,418,537	A	5/1995	Bird
5,563,579	A	10/1996	Carter
5,652,564	A	7/1997	Winbush
5,661,473	A	8/1997	Paschal
5,895,436	A	4/1999	Savoie et al.
5,929,753	A	7/1999	Montague
5,951,611	A	9/1999	La Pierre
5,991,673	A	11/1999	Koopman, Jr. et al.
6,025,774	A	2/2000	Forbes
6,034,596	A	3/2000	Smith et al.
6,052,065	A	4/2000	Glover
6,060,981	A	5/2000	Landes
6,067,007	A	5/2000	Gioia
6,157,317	A	12/2000	Walker
6,184,801	B1	2/2001	Janky
6,216,066	B1	4/2001	Goebel et al.
6,222,463	B1	4/2001	Rai
6,262,659	B1	7/2001	Korkosz et al.
6,292,723	B1	9/2001	Brogan et al.
6,298,306	B1	10/2001	Suarez et al.
6,301,531	B1	10/2001	Pierro et al.
6,314,350	B1	11/2001	Butz et al.

(Continued)

FOREIGN PATENT DOCUMENTS

GB	2335002	9/1999

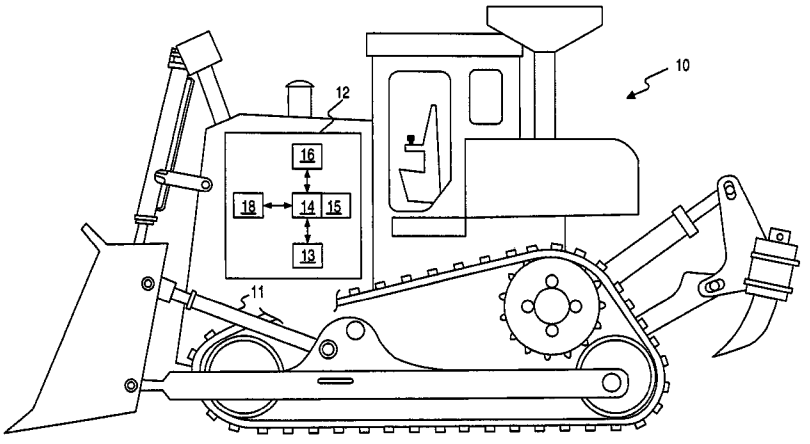
(Continued)

Primary Examiner—Daniel A Hess
(74) *Attorney, Agent, or Firm*—Finnegan, Henderson, Farabow, Garrett & Dunner LLC

(57) **ABSTRACT**

A method for operating a machine and/or a component of the machine includes collecting machine data from the machine and/or machine component over a communications network. The machine data includes data reflecting at least one operational parameter associated with the machine and/or machine component. The method also includes determining that the machine and/or machine component is in an abnormal condition based on the collected machine data, and derating the machine and/or machine component based on determining that the machine and/or machine component is in the abnormal condition.

15 Claims, 3 Drawing Sheets



U.S. PATENT DOCUMENTS

6,336,065	B1	1/2002	Gibson et al.
6,339,745	B1	1/2002	Novik
6,366,199	B1	4/2002	Osborn et al.
6,405,108	B1	6/2002	Patel et al.
6,408,259	B1	6/2002	Goebel et al.
6,434,458	B1	8/2002	Laguer-Diaz et al.
6,437,705	B1	8/2002	Barich et al.
6,490,513	B1	12/2002	Fish et al.
6,501,849	B1	12/2002	Gupta et al.
6,502,018	B1	12/2002	Bessler
6,539,271	B2	3/2003	Lech et al.
6,543,007	B1	4/2003	Bliley et al.
6,580,983	B2	6/2003	Laguer-Diaz et al.
6,591,182	B1	7/2003	Cece et al.
6,611,740	B2	8/2003	Lowrey et al.
6,636,771	B1	10/2003	Varma et al.
6,636,790	B1	10/2003	Lightner et al.
6,643,801	B1	11/2003	Jammu et al.
6,647,356	B2	11/2003	Pierro et al.
6,650,949	B1	11/2003	Fera et al.
6,651,034	B1	11/2003	Hedlund et al.
6,691,064	B2	2/2004	Vroman
6,708,038	B1	3/2004	Laguer-Diaz et al.
6,732,031	B1	5/2004	Lightner et al.
6,738,931	B1	5/2004	Osborn et al.
6,781,513	B1	8/2004	Korkosz et al.
6,791,456	B2	9/2004	Nakayama et al.
6,799,154	B1	9/2004	Aragones et al.
6,801,312	B1	10/2004	Tiwald
6,833,787	B1	12/2004	Levi
6,850,869	B2	2/2005	Pierro et al.
6,856,968	B2	2/2005	Cooley et al.
6,885,903	B2	4/2005	Olle et al.
6,901,377	B1	5/2005	Rosenfeld et al.
6,917,306	B2	7/2005	Lilja
6,947,797	B2	9/2005	Dean et al.
6,950,829	B2	9/2005	Schlabach et al.
6,957,133	B1	10/2005	Hunt et al.
6,959,235	B1	10/2005	Abdel-Malek et al.
6,980,124	B2	12/2005	Kong et al.
6,985,803	B2	1/2006	Abdel-Malek et al.
6,988,011	B2	1/2006	Varma et al.
6,993,675	B2	1/2006	Roddy et al.
6,996,498	B2	2/2006	Pierro et al.
7,031,239	B2	4/2006	Takahashi et al.
7,031,878	B2	4/2006	Cuddihy et al.
7,471,192	B2	12/2008	Hara et al.
2002/0173885	A1	11/2002	Lowrey et al.
2004/0003249	A1	1/2004	Dabbish et al.
2004/0004540	A1	1/2004	Komatsu et al.
2004/0235516	A1	11/2004	Otsuki et al.
2004/0236489	A1	11/2004	Shibamori et al.
2005/0171660	A1	8/2005	Woolford et al.
2006/0041380	A1	2/2006	Motoyama et al.
2006/0055564	A1	3/2006	Olsen et al.
2006/0071783	A1	4/2006	Culpepper et al.
2006/0095175	A1	5/2006	deWaal et al.

FOREIGN PATENT DOCUMENTS

GB	2335002	A	9/1999
GB	2374227	A	10/2002
GB	2420052	A	5/2006
JP	2000-259900		9/2000
JP	2001-343446		12/2001
WO	WO 98/56626		12/1998

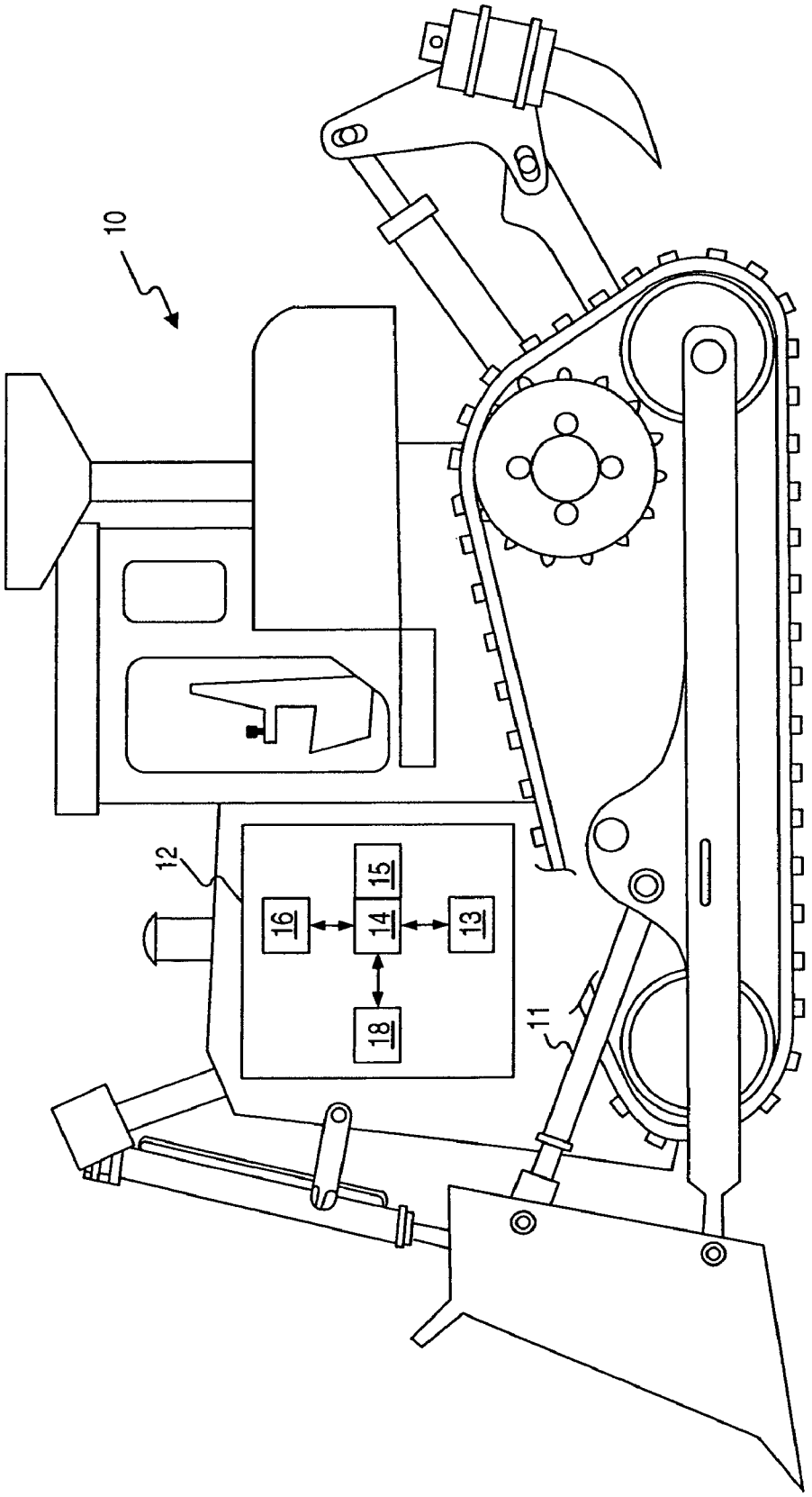


FIG. 1

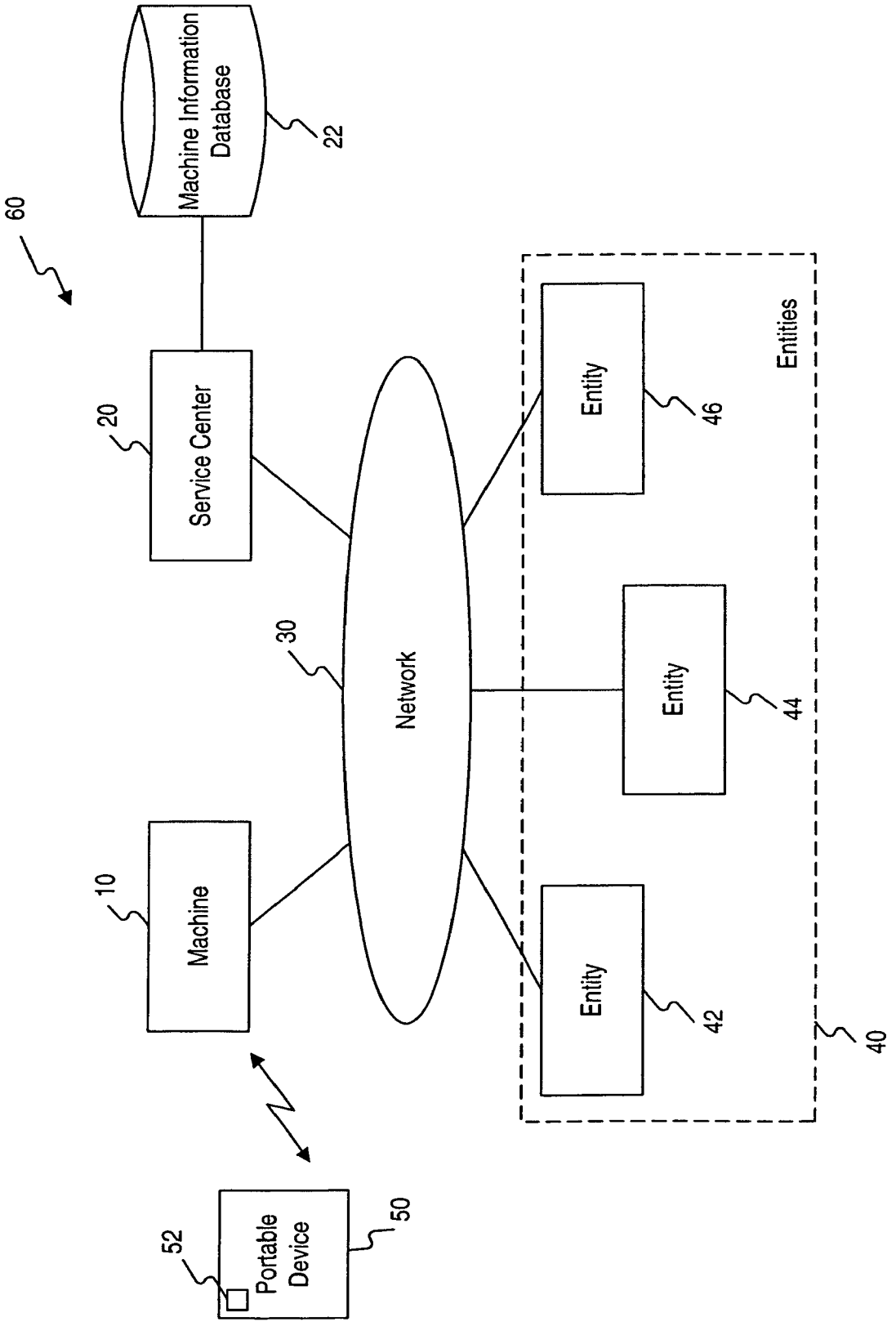

60
Machine Information Database
22
Service Center
20
Network
30
Machine
10
Entity
46
Entity
44
Entity
42
Entities
40
Portable Device
50
52

FIG. 2

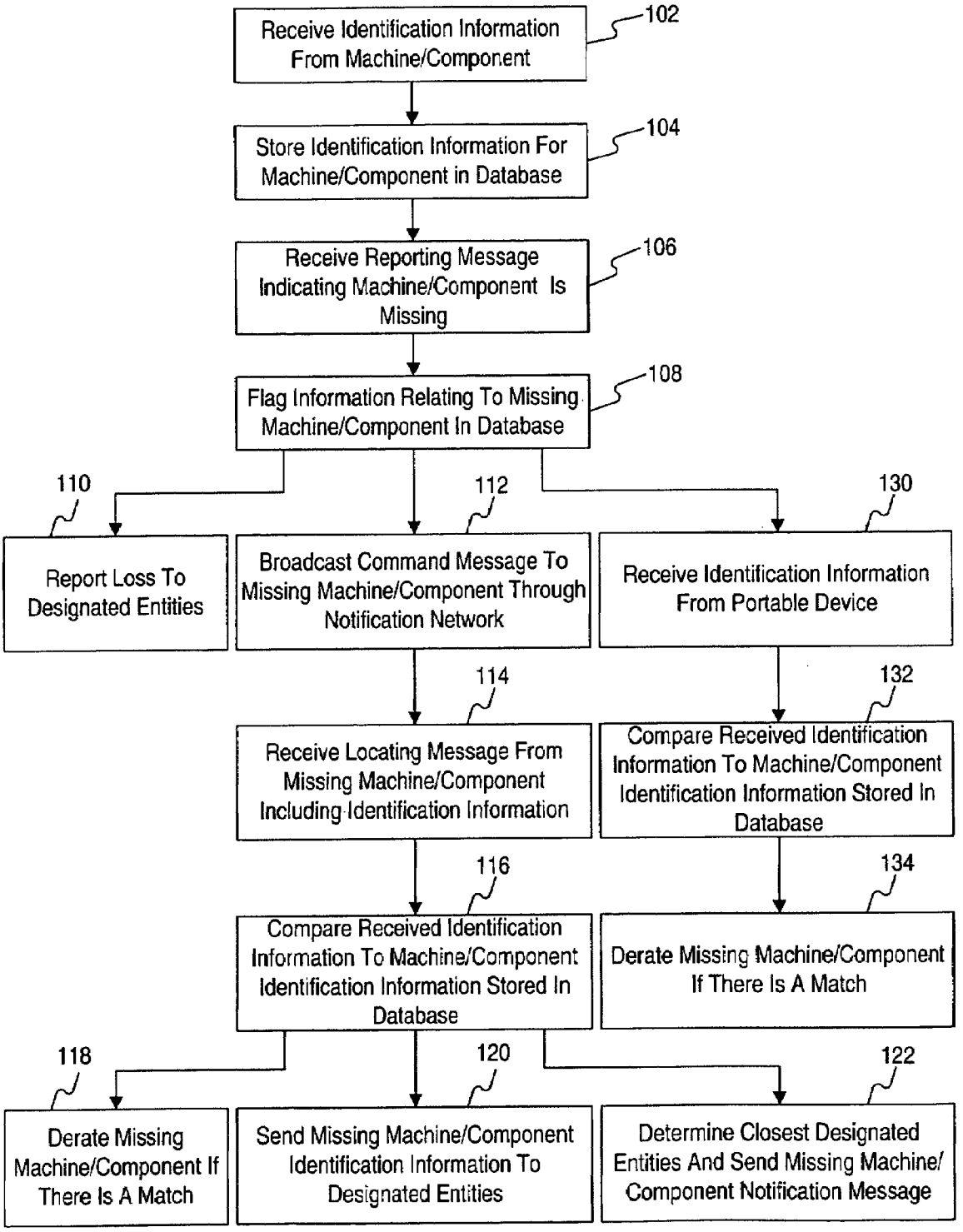

Receive Identification Information From Machine/Component
102
Store Identification Information For Machine/Component in Database
104
Receive Reporting Message Indicating Machine/Component Is Missing
106
Flag Information Relating To Missing Machine/Component In Database
108
110
Report Loss To Designated Entities
112
Broadcast Command Message To Missing Machine/Component Through Notification Network
130
Receive Identification Information From Portable Device
114
Receive Locating Message From Missing Machine/Component Including Identification Information
132
Compare Received Identification Information To Machine/Component Identification Information Stored In Database
116
Compare Received Identification Information To Machine/Component Identification Information Stored In Database
134
Derate Missing Machine/Component If There Is A Match
118
Derate Missing Machine/Component If There Is A Match
120
Send Missing Machine/Component Identification Information To Designated Entities
122
Determine Closest Designated Entities And Send Missing Machine/Component Notification Message

FIG. 3

METHOD AND SYSTEM FOR OPERATING MACHINES

RELATED APPLICATION

This is application is a continuation-in-part of application Ser. No. 11/477,514 filed on Jun. 30, 2006, for "Method And System For Providing Signatures For Machines," which is incorporated herein by reference.

TECHNICAL FIELD

The present disclosure relates generally to a method and system for locating machines, and more particularly, to a method and system for operating machines.

BACKGROUND

Machines and machine components have routinely been the target of thieves, especially when there is a need for equipment, such as after a natural disaster. Stolen machines may be stripped and sold for parts, and therefore, create difficulties for authorities and machine owners to identify missing parts. To assist with identifying machines and machine components, markings are used, such as labels, etchings, etc., that uniquely identify a given component or machine. However, these markings may be removed or altered to change the identification information.

Furthermore, law enforcement officials may not be trained to identify machines properly. For example, transported machines that are subject to inspection may have identification information printed on a component or sticker attached to the machine. However, alterations to the identification information frustrate the machine identification process. That is, law enforcement attempts to accurately identify machines with altered markings and identifications hinder the ability to locate missing machines and components.

One method of locating a missing vehicle is described in U.S. Pat. No. 5,418,537 (the '537 patent) to Bird. In the system disclosed by the '537 patent, a vehicle owner notifies a vehicle location service center that a vehicle is missing. In response, the vehicle location service center broadcasts a paging request. The paging request is received by the vehicle, which sends its present location to the vehicle location service center so that the vehicle can be recovered.

Although the system of the '537 patent provides a method for recovering missing vehicles by broadcasting a paging request to the missing vehicle, the method has some drawbacks. For example, once the missing vehicle is located electronically, there is a time delay until the actual retrieval of the vehicle because the person retrieving the missing vehicle must travel to the location of the vehicle. Thus, the missing vehicle may be moved while the person sent to retrieve the missing vehicle is en route to the vehicle's detected location. Furthermore, if the paging responder or a similar device is removed from the vehicle, the vehicle is unable to respond to the paging request and thus unable to be located.

The disclosed system is directed to overcoming one or more of the problems set forth above.

SUMMARY OF THE INVENTION

In one aspect, the present disclosure is directed to a method for operating a machine and/or a component of the machine. The method includes collecting machine data from the machine and/or machine component over a communications network. The machine data includes data reflecting at least one operational parameter associated with the machine and/or machine component. The method also includes determining that the machine and/or machine component is in an abnormal condition based on the collected machine data, and derating the machine and/or machine component based on determining that the machine and/or machine component is in the abnormal condition.

In another aspect, the present disclosure is directed to a system for operating a machine and/or a component of the machine. The system includes a service center configured to collect and store machine data from the machine and/or machine component over a communications network. The machine data includes data reflecting at least one operational parameter associated with the machine and/or machine component. The service center is also configured to determine that the machine and/or machine component is in an abnormal condition based on the collected machine data, and send a command to the machine and/or machine component to derate based on determining that the machine and/or machine component is in the abnormal condition.

In yet another aspect, the present disclosure is directed to a method for operating a machine and/or a component of the machine. The method includes storing machine data associated with the machine and/or machine component. The machine data includes data reflecting at least one operational parameter associated with the machine and/or machine component. The method also includes determining that the machine and/or machine component is in an abnormal condition based on the machine data, and automatically derating the machine and/or machine component based on the determining that the machine and/or machine component is in the abnormal condition.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a diagrammatic illustration of an exemplary machine consistent with disclosed embodiments;

FIG. **2** is a schematic diagram illustrating an exemplary communication system consistent with disclosed embodiments; and

FIG. **3** is a flow chart illustrating an exemplary machine locating process consistent with disclosed embodiments.

DETAILED DESCRIPTION

FIG. **1** illustrates an exemplary machine **10** having one or more components **11**. A machine component **11** may be an electronic, electrical, mechanical, electro-mechanical, etc., portion of machine **10** that performs some operation related to the overall operation of machine **10** (e.g., a hydraulic component, an engine, a transmission, etc.). Machine **10** may embody a fixed or mobile machine that performs some type of operation associated with an industry such as mining, construction, farming, transportation, or any other industry known in the art. For example, machine **10** may be a commercial machine, such as a truck, crane, earth moving machine, mining vehicle, material handling equipment, farming equipment, marine vessel, aircraft, an excavator, a dozer, a loader, a backhoe, a motor grader, a dump truck, or any type of machine that operates in a work environment such as a construction site, mine site, power plant, etc.

Machine **10** may be equipped with a data communication system **12**, which includes at least one electronic control module (ECM) **13**, a gateway processor device **14**, a transceiver device **15**, and a global positioning satellite (GPS) device **16**. Although the following description relates to the identification of machine **10**, one or more machine compo-

nents **11** may each also be equipped with data communication system **12**. Accordingly, in certain embodiments, machine **10** may include multiple data communication systems **12** mounted on one or more separate machine components **11**.

Data communication system **12** may be a system configured to collect and transmit machine data, location data, and identification data. In one embodiment, ECM **13** stores machine data including, for example, identification information specific to machine **10**. For example, the identification information may include a machine identifier (e.g., a serial number, registration number, or other information assigned to machine **10**). Further, ECM **13** may collect and/or store other types of machine data, such as scheduling data (e.g., when machine **10** is scheduled to change location and/or how long machine **10** is scheduled to remain at a location, identification of types of authorized operations during scheduled shifts, etc.), machine operational data (e.g., operational historical parameter data (e.g., oil pressure, motor speed, temperatures, fluid levels, and/or other parameter data related to the operation of machine **10** or a component **11**)), timings, fault codes, etc. ECM **13** may collect the machine data from one or more machine components **11**. Alternatively, or in addition, ECM **13** may collect machine data from one or more other ECMs **13** associated with one or more other machine components **11**.

ECM **13** may also be associated with at least one sensor (not shown) for monitoring and recording at least one type of machine data. For example, an engine ECM may receive signals from engine sensors, such as, for example, an atmospheric pressure sensor, a fuel flow sensor, a boost pressure sensor, a water temperature sensor, and an engine speed sensor. Additional sensors may be included to measure other properties of the engine as necessary, as would be apparent to one skilled in the art. Another exemplary ECM is a transmission ECM, which may be associated with sensors that monitor the transmission, such as a gear code sensor, a transmission output speed sensor, and a differential oil temperature sensor. Other sensors may be associated with the transmission ECM as would be apparent to one skilled in the art.

As explained, machine **10** may include multiple ECMs **13**. Each of these ECMs **13** may be different types of ECMs **13**. For example, machine **10** may include a hydraulic system ECM, a chassis ECM, and/or a brake/cooling ECM. These other ECMs may also be associated with one or more sensors for collecting machine data related to one or more machine components **11**, such as a hydraulic system, the chassis, the brake/cooling systems, etc. Other sensors and ECMs may be included for collecting machine data related to other components as would be apparent to one skilled in the art. Each ECM may be associated with one or more sensors, and the specific types of sensors and the number of sensors associated with each ECM may be based on the type of application and information to be obtained by the sensors.

Gateway processor device **14** includes one or more processor devices that execute program instructions to perform various functions such as requesting and/or receiving information from ECM **13** and GPS device **16**. Further, gateway processor device **14** may generate messages to transmit to an off-board system, such as a service center **20** (FIG. **2**). Gateway processor device **14** may be configured with different types of hardware and/or software (e.g., a microprocessor, a gateway, a product link device, a communication adapter, etc.). Gateway processor device **14** may also provide interface functions for transmitting data to, and receiving data from, data communication system **12**. Further, gateway processor device **14** may execute software for performing one or more functions consistent with the disclosed embodiment. Also, gateway processor device **14** may include storage device(s) for maintaining data for use by one or more on-board modules (e.g., ECM **13**), or one or more off-board systems (e.g., service center **20**). For example, gateway processor device **14** may be configured to perform protocol conversions (e.g., tunneling and translations), intelligent routing, and server-based operations, such as data provisioning, application provisioning, Web server operations, electronic mail server operations, data traffic management, and any other type of server-based operations that enable data communication system **12** to retrieve, generate, and/or provide data with off-board systems, e.g., service center **20**. For clarity of explanation, FIG. **1** shows gateway processor device **14** as a distinct element. However, "gateway" functionality may be implemented via software, hardware, and/or firmware within other one or more on-board modules, such as ECM **13**, which communicates with off-board systems. Thus, gateway processor device **14** may, in certain embodiments, represent functionality or logic embedded within another element.

Transceiver device **15** includes one or more devices that transmit and receive information, such as information collected and stored by gateway processor device **14** from ECM **13** and GPS device **16**. Transceiver device **15** may transmit the information to an off-board system, such as service center **20**. Further, transceiver device **15** may receive information, such as requests for machine information from service center **20**. Alternatively, transceiver device **15** may represent separate transmission and receiver devices, or other devices for providing a communication interface between machine **10** and service center **20**.

GPS device **16** generates location data, e.g., GPS coordinates, for machine **10** based on data from a satellite, local tracking system, or any other position sensing system known in the art. The location data may be collected by gateway processor device **14** and may be transmitted to service center **20** via transceiver device **15**.

FIG. **2** illustrates an exemplary communication system **60** including machine **10**, service center **20** including a machine information database **22**, a network **30** including, e.g., one or more additional wireless and/or wire-line communication networks (e.g., satellite networks, RF networks, fiber optic or coaxial cable based networks, twisted pair telephone line networks, or any other type of communication network), and other entities **40**, e.g., owners (not shown), dealers **42**, law enforcement **44**, and vendors **46**. According to certain embodiments, communication system **60** may perform one or more processes for identifying and/or locating machines **10** and/or machine components **11** implemented with a data communication system **12**. The interaction within communication system **60** to locate and identify a machine **10** is described below with reference to FIG. **3**.

FIG. **3** is a flow chart showing an exemplary machine locating process consistent with certain disclosed embodiments to collect and store information regarding machine **10** and/or component **11** to locate a missing machine **10** and/or component **11**. In one embodiment, service center **20** receives machine data from data communication system **12** associated with machine **10** and/or component **11** (step **102**). As described above, the machine data may include identification information assigned to machine **10** and/or component **11**, machine data reflecting operational characteristics of machine **10** and/or machine component **11**, etc. For example, the machine data may include one or more machine parameters, e.g., a machine identifier, a historical operational parameter, work site information or other scheduling operational parameter, and/or a fault code. The machine data is unique to a particular machine **10** and/or component **11** and may include a series of values or a string of digits. Service

center **20** may also receive location data related to machine **10** and/or component **11**, which is determined using GPS device **16**, for machine **10** from data communication system **12**.

Service center **20** may store the machine data received from machine **10** and/or component **11** in machine information database **22** (step **104**). Steps **102** and **104** may be executed one or more times during the lifetime of machine **10** (e.g., following an assembly of machine **10**, before machine **10** has been delivered to a work site, and/or after delivery of machine **10** to the work site). Further, steps **102** and **104** may be executed once, after a predetermined event has occurred, or periodically at regular time intervals.

During operation, machine **10** and/or component **11** may periodically, or as demanded by service center **20**, provide a status report to service center **20**. For example, at the end of a shift for machine **10** (e.g., at the end of the day), machine **10** and/or component **11** may automatically provide a status report, including location data, scheduling data, and/or machine data, to service center **20**.

Aspects related to certain embodiments enable the machine data to be used to locate and verify the identity of a machine or machine component. In circumstances where a machine **10** and/or component **11** is reported to be in an abnormal condition, such as when it is missing (e.g., stolen, not returned at end of lease, moved from authorized locations, performing operations or tasks outside defined thresholds or time constraints, unscheduled operation, etc.), trigger events may be implemented to initiate processes for locating and/or verifying the identity of the inspected machines or components. Thus, machine **10** and/or component **11** may be determined to be missing based on an unscheduled trigger event, e.g., starting, changing operations, changing operators, moving, etc. For example, gateway processor device **14** may store scheduling data for machine **10** indicating when machine **10** is scheduled to operate and when it is scheduled not to operate. Gateway processor device **14** may also receive machine data (e.g., engine data from an engine ECM indicating when the engine has started, transmission data from a transmission ECM indicating when the transmission is operating, etc.). Gateway processor device **14** may compare the scheduling data to the machine data, e.g., in real time or periodically, to determine whether there is a conflict (i.e., machine **10** and/or component **11** is operating when it is not scheduled). As a result, gateway processor device **14** may generate and send a reporting message to service center **20** via transceiver device **15** indicating that machine **10** and/or component **11** is missing. The reporting message may include machine data, such as identification information used by service center **20** to identify machine **10** and/or component **11** from other machines and/or components listed in machine information database **22**. Alternatively, instead of missing machine **10** sending the reporting message directly to service center **20**, an owner of missing machine **10** and/or component **11**, or another entity **40** (e.g., dealers **42**, law enforcement **44**, and vendors **46**) may generate and send the reporting message to service center **20** after determining that the machine is missing.

In another embodiment, service center **20** may store scheduling data for machine **10** and/or component **11**. Further, service center **20** may receive messages periodically from machine **10** and/or component **11** that include location data for machine **10** and/or component **11**. The messages received from machine **10** and/or component **11** may also include other identification information, such as the machine data used to identify machine **10** and/or component **11**. Service center **20** may compare the location data to the stored scheduling data to determine whether there is a conflict. If so, service center **20** may identify an abnormal condition for machine **10** and/or component **11**.

Service center **20** receives the message reporting that machine **10** and/or component **11** is missing (step **106**). Alternatively, service center **20** may determine that machine **10** and/or component **11** is missing based on other information (e.g., machine data). Service center **20** uses machine data included in the reporting message to identify the machine data associated with machine **10** and/or component **11** in machine information database **22**. Service center **20** may then flag the information in machine information database **22** associated with missing machine **10** and/or component **11** (step **108**). Service center **20** may also report the loss to law enforcement **44** or other entities **40** (step **110**).

After flagging the machine data in machine information database **22**, service center **20** may also send command messages through network **30** to command all missing machines **10** and/or components **11** that are flagged in machine information database **22** to reply with a locating message (step **112**). In response to the command message from service center **20**, missing machine **10** and/or component **11** may transmit the locating message to service center **20** via network **30** (step **114**). The locating message may include location data associated with missing machine **10** and/or component **11** determined by GPS device **16** and machine data including identification information associated with missing machine **10** and/or component **11** (e.g., one or more historical operational parameters, scheduling operational parameters, and/or other machine data used to uniquely identify machine **10** and/or component **11**).

In one embodiment, the specific parameters of machine data provided by missing machine **10** and/or component **11** in the locating message may be specified by service center **20** in the command message. For example, in the command message, service center **20** may request that missing machine **10** include in the locating message the same parameters used to identify the machine **10** in machine information database **22**. In another embodiment, the specific parameters of identification information provided by missing machine **10** and/or component **11** in the locating message may be determined automatically by missing machine **10** and/or component **11**. Machine **10** and/or component **11** stores information identifying the specific parameters used to identify the machine **10** in machine information database **22** and may send the specified parameters to service center **20** when requested.

Service center **20** compares the received machine data to the machine data associated with machines **10** and/or components **11** stored in machine information database **22** (step **116**). Because the same parameters are used to identify machine **10** and/or component **11**, the machine data for machine **10** and/or component **11** received in the locating message may be identical to stored machine data for the same machine **10** and/or component **11** that is stored in machine information database **22**. In one embodiment, the machine data may be substantially identical. That is, sets of data are substantially identical when they are equal to within a predetermined range, threshold, etc., of sets of data, such as a percentage value (e.g., 1%), a decimal value, (e.g., within 0.0001, 0.001, 0.01, 0.1, etc.), or any other type of threshold or range. Thus, when the machine data received in the locating message matches (or substantially matches) one of the sets of machine data listed in database **22**, service center **20** may determine the identity of missing machine **10**. The comparison of the machine data may require an exact match or a substantial match. For example, to attain an exact match, service center **20** may determine that the machine data from the locating message matches one of the sets of machine data

stored in database **22** when each digit in the set of machine data from the locating message is identical to a corresponding digit of one of the sets of machine data stored in database **22** (e.g., 00111 and 00111). On the other hand, to attain a substantial match, service center **20** may identify machine **10** and/or machine component **11** when a predetermined number of digits (or a predetermined percentage of digits, etc.) match (e.g., 00111 and 0011x).

For example, the locating message from missing machine **10** and/or component **11** may include location data and an identifier. When service center **20** receives the locating message, service center **20** compares the identifier received from missing machine **10** and/or component **11** in the locating message to the identifiers stored in machine information database **22** for the missing machines. If there is a match, then the identity of missing machine **10** and/or component **11** has been determined, and service center **20** sends a message to machine **10** and/or component **11** to derate its performance, e.g., by decreasing engine speed of the engine associated with machine **10** and/or component **11** (step **118**). In one embodiment, the engine speed may be decreased such that it does not exceed a predetermined speed, such as a low idle speed or other predetermined low engine speed. Therefore, the engine speed may be automatically decreased such that machine **10** and/or component **11** may perform limited operations depending on the particular machine and/or component. For example, when derated, machine **10** may disable any components **11**, but still be able to travel at low speeds. Alternatively, components **11** may be operated at a low power, thereby limiting their use. Furthermore, in one embodiment, derating component **11** may have an effect on a derating of machine **10**. For example, if component **11** is derated based on a trigger event, machine **10** may also be automatically derated, e.g., the engine speed may be decreased. The derating of component **11** and/or machine **10** may be proportional or disproportional as based on mappings, rules, an expert system, etc.

By derating engine speed, machine **10** and/or component **11** may be capable of outputting only a fraction of its normal power. For example, machine **10** and/or component **11** may be prevented from moving at higher speeds and may be limited to moving at slower speeds or a crawl, and/or may not have sufficient power to dig or perform other types of operations. By derating engine speed, the transmission may also be derated and may only have enough power to work in certain low gears. For example, after derating, the transmission may only have enough power to operate in first gear, and therefore, the operator of machine **10** may not be able to shift to any higher gears.

One or more trigger events may be implemented to initiate processes for derating the performance of machine **10** and/or component **11**. In one embodiment, the derating process may be initiated automatically by machine **10** and/or component **11**. For example, machine **10** and/or component **11** may automatically initiate the derating process if it determines that it is in an abnormal condition (e.g., stolen, not returned at end of lease, moved from authorized locations, performing operations or tasks outside defined thresholds or time constraints, unscheduled operation, etc.). In one embodiment, if it is determined that machine **10** and/or component is outside a location in which it is authorized to be (e.g., based on a comparison between its location data and scheduling data) or outside a predetermined area surrounding the location (e.g., a 5 mile radius around the location), then machine **10** and/or component **11** may automatically initiate the derating process. The derating process may also be automatically initiated if machine **10** and/or component **11** enters a location in which it is unauthorized to be or within a predetermined area surrounding such a location. Machine **10** and/or component **11** may also automatically initiate the derating process if it is determined that machine **10** and/or component **11** is being abused, such as when a predetermined number of fault codes or other diagnostic codes have been triggered, parameters exceeded, etc., for a particular component **11**, a subset of components **11**, and/or for machine **10**. Fault codes may be automatically generated by machine **10** and/or component **11** when machine **10** and/or component **11** detects operations that may cause damage, such as when the engine is run above a predetermined limit (overspeed). The fault codes may be stored by ECM **13**.

In another embodiment, the derating process may be initiated by service center **20**, a portable device **50** (FIG. **2**), and/or entity **40** (e.g., dealers **42**, law enforcement **44**, and vendors **46**), such as when service center **20**, portable device **50**, and/or entity **40** has determined that machine **10** and/or component **11** is in need of inspection. For example, service center **20**, portable device **50**, and/or entity **40** may initiate the derating process based on one or more trigger events, such as the trigger events described above. Service center **20**, portable device **50**, and/or entity **40** may also initiate the derating process if it has been determined that machine **10** and/or component **11** is being repossessed. In one embodiment, service center **20**, portable device **50**, and/or entity **40** may send a derating start command to machine **10** and/or component **11** to initiate the derating process.

The disclosed embodiments also allow the derating process to be delayed to address safety issues related to machine operations. For example, machine **10** and/or component **11** may be derated after completion of a job or task. For example, to avoid safety problems, service center **20** may send a command that instructs ECM **13** of machine **10** to derate the engine speed after machine **10** and/or component **11** is shut down manually. In another embodiment, machine **10** may automatically derate its engine speed after machine **10** and/or component **11** is shut down manually. Thus, machine **10** and/or component **11** can complete operations, but the engine speed will be derated when it is started up again after shutdown.

After derating machine **10** and/or component **11**, the operator of machine **10** and/or component **11** may contact service center **20** to determine the cause of the derating. Alternatively, or additionally, service center **20** or other entity **40** may contact the operator of machine **10** and/or component **11** to communicate the cause of the derating. In another embodiment, machine **10** and/or component **11** may automatically receive from service center **20** or other entity **40** information identifying the cause of the derating. This information may be presented to the operator of the derated machine **10** and/or component **11** (e.g., displayed, text messaged, etc.).

Machine **10** and/or component **11** may receive a derating end command that includes data known by personnel who are authorized to end the derating (e.g., personnel of service center **20**, the dealer **42** or vendor **46** for the particular machine **10** and/or component **11**, the owner of machine **10** and/or component **11**, etc.). The derating end command may be input manually using an input device (e.g., a keypad, portable device **50**, etc.) or by transmitting a command that is received by transceiver device **15**. For example, if machine **10** and/or component **11** was derated because it generated over ten fault codes, service center **20** may send a service technician to inspect machine **10** and/or component **11** before entering the proper code to end the derating. Alternatively, the derating may end when the trigger event that caused the derating is addressed, reversed, and/or eliminated. For example, if machine **10** and/or component **11** leaves its autho-

rized location, the derating process may end when machine **10** and/or component is returned to its authorized location. As a result, the operator of machine **10** and/or component **11** may be unable to end the derating without communicating with service center **20** or other entity **40** or without altering the operations of machine **10** and/or component **11**.

After determining the identity of missing machine **10** and/or component **11**, service center **20** may also send a missing machine notification message to one or more designated entities **40** (e.g., owners, dealers **42**, law enforcement **44**, and/or vendors **46**) (step **120**). The missing machine notification message identifies missing machine **10** and/or component **11** and may include, for example, a message indicating that missing machine **10** and/or component **11** is reported as missing, a machine identifier, and/or location data received in the locating message from missing machine **10** and/or component **11**. This information may be used to identify, locate, retrieve, and/or return machine **10** and/or component **11** to its owner.

Service center **20** may also store location data for entities **40** and determine one or more entities **40** that are within a selected geographical range from missing machine **10** and/or component **11** based on the location data received in the locating message from missing machine (e.g., within a predetermined radius from missing machine **10** and/or component **11**). Service center **20** may send the missing machine notification message to one or more geographically closest entities (step **122**).

Portable device **50** (FIG. **2**) may also be used to determine the identity of machine **10** and/or component **11**. Portable device **50** may be a handheld or portable device used by one or more entities **40**, e.g., dealers **42**, law enforcement **44**, and/or vendors **46**. Portable device **50** may be a handheld computer (e.g., a laptop, personal digital assistant (PDA), etc.), implemented using, for example, PALM® or PocketPC® technology and wireless capabilities. Entity **40** may use portable device **50** to receive information using, for example, a sensor (e.g., an RFID reader or bar code reader) that gathers information from a communication port **18** on machine **10** and/or component **11**. The communication port **18** is connected to gateway processor device **14** to allow the information stored on gateway processor device **14** and/or ECM **13** to be transferred to portable device **50**. Alternatively, a wireline link may be provided to removably attach portable device **50** to communication port **18**, e.g., a Universal Serial Bus (USB) port, RS 232 port, or a port using another communication protocol in data communication system **12**. Entity **40** may be able to access information received from gateway processor device **14** by executing software performed by portable device **50**. Portable device **50** may also include a transceiver device **52** that allows portable device **50** to transmit information to and receive information from service center **20**. Transceiver device **20** may transmit or receive information via wireless or wireline network to service center **20**.

In one embodiment, portable device **50** may read machine data (e.g., identification information) from communication port **18** on machine **10** and/or component **11** and may transmit the machine data to service center **20** (step **130**). The specific parameters of the machine data read by portable device **50** may be identified based on information stored in portable device **50**.

Service center **20** may compare the received machine data to machine data associated with one or more machines and/or components stored in machine information database **22** (step **132**). Service center **20** may identify machine **10** and/or component **11** if, for example, the received machine data matches the machine data for a machine **10** and/or component **11** listed in machine information database **22**. After determining the identity of machine **10** and/or component **11**, if it is determined that machine **10** and/or component **11** is flagged as a missing machine and/or component, service center **20** may send a missing machine notification message to portable device **50**. The missing machine notification message may include machine data such as a machine identifier and/or location data.

For example, portable device **50** may read machine data (e.g., identification information) from machine **10** and/or component **11** and may transmit the machine data to service center **20**. Service center **20** compares the machine data received from portable device **50** to the machine data stored in machine information database **22** for flagged missing machines and/or components. If the machine data read by portable device **50** matches (or substantially matches) one of the sets of machine data stored in machine information database **22**, service center **20** may generate data reflecting that the identity of machine **10** and/or component **11** is determined. After determining the identity of machine **10** and/or component **11**, service center **20** may determine whether machine **10** and/or component **11** is flagged as a missing machine. If so, service center **20** may send a missing machine notification message to portable device **50**. The missing machine notification message may include a machine identifier, location data, and any other information related to the machine (e.g., identity of the owner, contact information, etc.).

Alternatively, or additionally, portable device **50** may also execute a process that determines the identity of machine **10** and/or component **11** (step **148**). To do so, portable device **50** may execute processes similar to those described above in connection with service center **20**. For example, portable device **50** may compare the machine data read from machine **10** and/or component **11** against a set of stored machine data downloaded from service center **20**. Portable device **50** may store data that is also stored in machine information database **22** and may receive periodic updates from service center **20**. If the machine data read from portable device **50** matches (or substantially matches) one of the stored sets of machine data, portable device **50** may generate data reflecting that the identity of machine **10** and/or component **11** has been determined. Portable device **50** may send this message to service center **20** for further processing. Thus, portable device **50** may be used to identify machine **10** without having to transmit the machine data that it reads from machine **10** and/or component **11** to service center **20**. After determining the identity of machine **10** and/or component **11**, portable device **50** may also determine if machine **10** and/or component **11** is flagged as a missing machine and may notify service center **20**. Then, service center **20** may send a missing machine notification message to designated entities **40**, e.g., dealers **42**, law enforcement **44**, and/or vendors **46**.

Further, after determining that machine **10** and/or component **11** is a missing machine, portable device **50** may, via direction by service center **20** or by executing software stored on portable device **50**, generate and send a message to machine **10** and/or component **11** commanding it to derate its performance, as described above (step **134**). Alternatively, if machine **10** and/or component **11** is in the middle of a job, portable device **50** may transmit a message to machine **10**

and/or component **11** to derate its performance after completing the job, a task, or any other type of event, etc.

INDUSTRIAL APPLICABILITY

The disclosed embodiments enable machines to be accurately identified and located. For example, machine **10** and/or component **11** may automatically send messages to service center **20** reporting that it is operating under an abnormal condition (e.g., stolen, not returned at end of lease, moved from authorized locations, performing operations or tasks outside defined thresholds or time constraints, unscheduled operation, etc.). Service center **20** may then automatically send missing machine notification messages to designated entities, e.g., local law enforcement, vendors, and dealers. Thus, these entities may be updated as to machine status, such as thefts. This reduces the time to recover a stolen machine, which for example may reduce the negative impact on the machine owner's business.

In one embodiment, a database listing missing machines **10** and/or components **11** may be maintained or it may be used to contact the missing machines **10** and/or components **11**. In situations where a missing machine **10** and/or component **11** may be unable to respond immediately to a message from service center **20** instructing machine **10** and/or component **11** to respond with its location data (e.g., because a battery in machine **10** and/or component **11** is removed or is dead), machine **10** and/or component **11** may delay its response (e.g., when the battery is replaced). Therefore, service center **20** may be able to contact missing machine **10** and/or component **11** by sending out the command message periodically.

In another embodiment, portable devices **50** may be provided to inspection agents (e.g., law enforcement, customs agents, dealers, etc.) for use during inspection of machine **10** and/or component **11** (e.g., at a stop and check on the highway, at a border, in a dealer lot, etc.). An inspection agent may be notified in response to machine **10** and/or component **11** determining that it has been stolen and/or when the owner of machine **10** and/or component **11** notifies service center **20**. Furthermore, an inspection agent may use portable device **50** to properly identify a machine **10** and/or component **11** that is being inspected and be notified if the machine has been reported missing. Accordingly, if the machine identification information inscribed on the machine is not readable and/or data communication system **12** on machine **10** and/or component **11** is unable to transmit identification information (e.g., transceiver device **15** is removed or damaged), the inspection agent may use portable device **50** to read the identification information from data communication system **12** on machine **10** and/or component **11** to determine its status.

In addition, after identifying a missing machine, service center **20** or portable device **50** may transmit a message to the missing machine and/or component to derate its performance, thereby preventing thieves from operating the missing machine and/or component at normal power, which may prevent the thieves from moving the missing machine and/or component to a different location when recovery personnel are en route to the machine's detected location. This also allows the machine and/or component to be recovered more quickly. If the missing machine and/or component is in the middle of operations, service center **20** or portable device **50** may transmit a message to the missing machine and/or component to initiate a delayed derating operation that derates the performance of the machine after completing a task, job, etc.

Derating instead of completely disabling machine **10** and/or component **11** eliminates the liability to the owner of machine **10** and/or component **11** if the machine and/or component is in an unsafe condition when it is disabled. For example, if a machine is derated when it is located in dangerous locations (e.g., railroad tracks), the machine may still be able to travel at idle speed out of danger. However, the derated machine may not be able to travel faster than idle speed and may not be able to operate any of its components **11**. As a result, the derated machine and/or component may be rendered inadequate for its intended use, but is not fully disabled, which would potentially create an unsafe environment.

Also, derating machine **10** and/or component **11** allows an owner of machine **10** and/or component **11** to protect its asset. For example, if an operator of machine **10** and/or component **11** is using machine **10** and/or component **11** in a manner that generates more than a predetermined number of fault codes, the operator may be abusing the machine and/or component. By derating machine **10** and/or component **11**, the owner of machine **10** and/or component **11** may be able to have a service technician inspect machine **10** and/or component **11** to determine whether an agreement, warranty, etc., has been breached. Even if it is determined that no damage has been done to machine **10** and/or component **11**, the derating process still allows the owner to inform the operator that machine **10** and/or component **11** is being used in an unauthorized manner, e.g., against terms of a leasing agreement, etc.

It will be apparent to those skilled in the art that various modifications and variations can be made to the method and system for inspecting machines. Other embodiments will be apparent to those skilled in the art from consideration of the specification and practice of the disclosed method and system for inspecting machines. It is intended that the specification and examples be considered as exemplary only, with a true scope being indicated by the following claims and their equivalents.

What is claimed is:

1. A method for operating at least one of a machine or a component of the machine, comprising:

collecting machine data from the at least one machine or machine component over a communications network, the machine data including data reflecting at least one operational parameter associated with the at least one machine or machine component;

determining that the at least one machine or machine component is in an abnormal condition based on the collected machine data, the abnormal condition including at least one of an unscheduled operation of the at least one machine or machine component, or an unscheduled change in location of the at least one machine or machine component; and

derating the at least one machine or machine component based on determining that the at least one machine or machine component is in the abnormal condition,

wherein the derating of the at least one machine or machine component includes disabling at least one machine component of the at least one machine or machine component and allowing the machine to travel.

2. The method of claim **1**, wherein the derating of the at least one machine or machine component includes decreasing an engine speed.

3. The method of claim **1**, further including:

receiving a command to derate the at least one machine or machine component; and

delaying the derating of the at least one machine or machine component based on an operation of the at least one machine or machine component.

4. The method of claim **1**, wherein the at least one machine or machine component automatically derates when the at

least one machine or machine component determines that the at least one machine or machine component is in the abnormal condition.

5. The method of claim **1**, further including sending a command to the at least one machine or machine component to direct the at least one machine or machine component to derate.

6. The method of claim **1**, further including:

providing a code to the at least one machine or machine component; and

ending the derating in response to the provided code.

7. The method of claim **1**, further including:

receiving, by the at least one machine or machine component, a command to end the derating; and

ending the derating after receiving the end derating command.

8. The method of claim **1**, further including automatically ending derating based on detecting that the at least one machine or machine component is no longer in an abnormal condition.

9. The method of claim **1**, further including:

receiving a notification that the at least one machine or machine component has been derated;

adjusting an operation of the at least one machine or machine component; and

ending the derating based on the adjusted operation.

10. The method of claim **1**, wherein the at least one disabled machine component includes at least one of a hydraulic component, an electro-mechanical component, or an electronic component of the machine.

11. A system for operating at least one of a machine or a component of the machine, comprising:

a service center configured to:

collect and store machine data from the at least one machine or machine component over a communications network, the machine data including data reflecting at least one operational parameter associated with the at least one machine or machine component,

determine that the at least one machine or machine component is in an abnormal condition based on the collected machine data, the abnormal condition includes leaving a predetermined area or entering a predetermined area by the at least one machine or machine component, and

send a command to derate the at least one machine or machine component based on the determining that the at least one machine or machine component is in the abnormal condition;

wherein the command to derate the at least one machine or machine component includes a command to delay the derating of the at least one machine or machine component based on an operation of the at least one machine or machine component.

12. The system of claim **11**, wherein the command to derate the at least one machine or machine component includes a command to decrease an engine speed.

13. A method for operating at least one of a machine or a component of the machine, comprising:

storing machine data associated with the at least one machine or machine component, the machine data including data reflecting at least one operational parameter associated with the at least one machine or machine component;

determining that the at least one machine or machine component is in an abnormal condition based on the machine data, the abnormal condition including at least one of an unscheduled operation of the at least one machine or machine component, or an unscheduled change in location of the at least one machine or machine component,

automatically derating the at least one machine or machine component based on the determining that the at least one machine or machine component is in the abnormal condition;

receiving a command to derate the at least one machine or machine component; and

delaying the derating of the at least one machine or machine component based on an operation of the at least one machine or machine component.

14. The method of claim **13**, wherein the derating of the at least one machine or machine component includes decreasing an engine speed.

15. The method of claim **13**, wherein derating of the at least one machine or machine component further includes derating the machine so that a transmission in the machine is capable of operating only in low gears.

* * * * *